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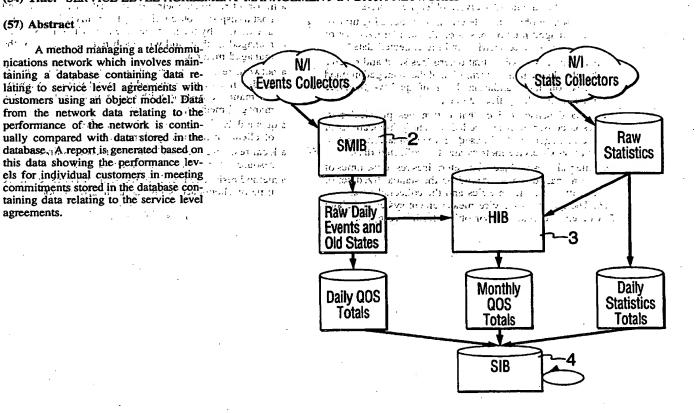
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### INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6: WO 98/42102 (11) International Publication Number: H04L 12/24, H04Q 11/04 A1 (43) International Publication Date: 24 September 1998 (24.09.98) (21) International Application Number: PCT/CA98/00232 (81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, IP, KE, KG, KP, KR, KZ, (22) International Filing Date: 16 March 1998 (16.03.98) LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, A 18 4 15 A. A. MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, (30) Priority Data: 2,200,009 2,200,011 TI, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian 14 March 1997 (14.03.97) patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European 14 March 1997 (14.03.97) ĆA 2,200,011 patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, 8 April 1997 (08.04.97) 60/043,080 LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, Cl, ా కోస్తాలు. అత్తి మార్క్షింత్రి - మిక్కా కోర్ క్రామ్స్ మీత్రామ్ మాత్రికి మీత్రికి CM, GA, GN, ML, MR, NE, SN, TD, TG). (71) Applicant (for all designated States except US): CROSSKEYS Mich Land SYSTEMS CORPORATION [CA/CA]; 350 Terry Fox Drive, Kanata, Ontario K2K 2W5 (CA). Published With international search report. (72) Inventors; and Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of (75) Inventors/Applicants (for US only): FORGET, Leo [CA/CA]; amendments. 55 Forest Creek, Stittsville, Ontario K2S; 1M1 (CA). CHRISTMAS, Mark [CA/CA]; 13 Riding Way, Kanata, Ontario K2M 1C3 (CA). (74) Agent: MITCHELL, Richard, J.; Marks & Clerk, P.O. Box 957, Station B, Ottawa, Ontario K1P 5S7 (CA).  $\phi(\widehat{f_A} \cap \mathcal{V}^{\times})$ al La Houan Ar (54) Title: SERVICE LEVEL AGREEMENT MANAGEMENT IN DATA NETWORKS

from the network data relating to the transmitted and the state of the performance of the network is continually compared with datasstored in the and and is database A report is generated based on this data showing the performance levels and the performance levels are the performance levels and the performance levels are the performance levels and the performance levels are the performance l els for individual customers in meeting commitments stored in the database containing data relating to the service level agreements.



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## SERVICE LEVEL AGREEMENT MANAGEMENT IN DATA NETWORKS

The present invention relates to a method of managing a telecommunications network, and in particular to a method of monitoring the compliance with service level agreements.

More and more telecommunications services are now becoming available to the consumer. In packet switched networks, unlike circuit switched networks, customers are not given a dedicated circuit; their data is statistically multiplexed with data from other sources. Each customer pays for a particular level of service, and it is therefore important to ensure that the customer is receiving the level of service he has paid for.

There is a thus need for a system that manages service level agreements (SLAs) between telecommunications service providers and their business customers. Part of the management process that relates to SLAs is the comparison of the service providers' performance vis-à-vis specific guarantees that it may provide to its customer. Such a system must be capable of handling vast amounts of data.

A object of the invention is to provide such a system.

According to the present invention there is provided a method managing a telecommunications network comprising the steps of maintaining a database containing data relating to service level agreements with customers using an object model, receiving from the network data relating to the performance of the network, comparing the data received from the network with data stored in said database, and generating a report based on said data showing the performance levels for individual customers in meeting commitments stored in said database containing data relating to service level agreements.

The method may be implemented, for example, on a Sun Sparc Ultra 2 Unix-based workstation and, for example, work in conjunction with a Newbridge Networks Corporation 46020 network manager.

In a preferred embodiment the event is generated when the discrepancy between performance levels and commitments exceed a predetermined threshold value.

As a specific example, consider a case where the service provider guarantees a

Cell Loss Ratio of a specific percentage for an ATM (Asynchronous Transfer Mode)

30 per PMC service. This ratio is guaranteed over a monthly period. A PVC (permanent virtual circuit) is a logical circuit between two points used to carry bi-directional information.

The Cell Loss Ratio indicates the quality of a specific service by providing a measurement of the amount of data loss by the service providen's network due to various reasons such as network congestion and network failure. The Cell Loss Ratio for an ATM

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35 PVC based service is calculated using the following formula:

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CLR = 
$$((\sum Ra + \sum Rz)) - (\sum Ta + \sum Tz))/(\sum Ra + \sum Rz) * 100$$
  
where CLR = Cell Loss Ratio and the content of th

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Ra = number of data cells received by the provider's network from side A

Rz = number of data cells received by the provider's network from side Z

Ta = number of data cells transmitted by the service provider to side A

Tz = number of data cells transmitted by the service provider to side Z.

Data which relates to Ra, Rz, Ta, and Tz is typically available from the ATM switching equipment in the form of statistical counters that are regenerated every fifteen minutes. Various other statistics, provided by the ATM switching equipment, are required for the verification of other service quality metrics.

These statistical counters must be collected by a management system in order to aggregate and summarize the various quality metrics associated with each service. This involves storing and managing millions of statistical counters that are required to manage the services offered by a typical service provider. In order to gain a better perspective as to the magnitude of this need, let's consider the following typical example:

A service provider must measure service performance metrics on 50,000 PVC services. Each PVC service generates 2 statistical reports per 15 minute interval (1 for each side of the PVC). Each statistical report consists of an identifier, a time stamp, and 8 statistical counters. Thus in this scenario, the management system must process 9.6 million records (50,000\*2\*96 intervals). Furthermore, raw statistical information must typically be available on-line for up to 60 days. Thus the system must manage (9.6 \* 60) 576 million records or 54 gigabytes of storage space.

Ideally, all of this information should be in one database table. Given the size of the table (576 million records), it must be indexed or searches in this table would be cumbersome and time consuming. Conversely, the processing to add 9.6 million records to an indexed table of 576 million records would take days, as the amount of time

25 required to load data into an indexed table grows exponentially with respect to the volume of data already in the table.

The difficulty is how to manage effectively and efficiently this vast quantity of data that changes rapidly in real time. This is quite a daunting task.

In a preferred embodiment, a plurality of working table fragments forming part of 30 a fragmented table are created in memory, data is loaded in successive predetermined time periods into successive table fragments in a predetermined sequence, and the data are processed separately when loaded into the table fragments.

The data are preferably loaded into said table fragments using a round robin table in the fragmentation strategy.

235 Comprising a database containing data relating to service level agreements with customers using an object model; means for receiving from the network data relating to the

performance of the network; means for continually comparing the data received from the network with data stored in said database, and means for generating a report based on said data-showing the performance levels for individual customers in meeting commitments stored in said database containing data relating to said service level agreements.

The invention still further provides a method of controlling a computer in an object-oriented environment wherein descriptors implemented as an object oriented class are used to store meta information on other classes in the system.

The invention will now be described in more detail; by way of example only, with reference to the accompanying drawings, in which:

- Figure 1 is a software architecture diagram of a system in accordance with the invention;
  - Figure 2 is a data flow diagram;
    - Figure 3 is a database entity relationship diagram for the object model;
      - Figure 4 shows the entities contained in the SMIB; and the shows the entities contained in the SMIB;
      - Figure 5 shows the entities contained in the HIB;
  - Figure 6 shows the entities contained in the SIB;
    - Figure 7 is a software Architecture Diagram showing daily data process flow;
    - Figure 8 shows the system table fragmentation strategy;
- Figure 9 shows a fragmented HIB table and related entries in the DBSpace usage table in the SMIB: 1 - 2 - 2 affile evaluation oppositions of the end of the grant
  - 20 Figure 10 illustrates the identifying and detaching aged data in a HIB table;
- Figure 11 illustrates the attaching of new data to a table in a HIB and updating the
- The Dispeace usage table in the SMIBs of the street of the life of
- Figure 12 shows combinations of start and completion times of states, caused by events in to not independ out of a million records would take done to the ARIMS affine
- Figure 13 shows the object models for a telcom information management architecture; Figure 14 illustrates the different types of descriptors that are employed in the system;
  - Figure 15: shows the top-layer object modeling of world significant body
    - Figure 16 shows the admin-entity in Figure 13 and this are some to and such
- Figure 17 shows the service layer object model of Figure 13.
- 30 As will be apparent from the following description, the invention implements an object model to efficiently construct the management system capable of handling a large volume of information. Referring now to Figure 1, Database Monitor (ckdbmon) 1 exchanges messages with the system databases, namely the service management information database (SMIB) 2, the historical information database (HIB)3, summarized information
  - 35. database (SIB) 4, and Network Interface Systems Director (the Keep Alive Process) 5.

things and journable to early for secepting that the runt had a reating to the

The ckdbmon lidoes not interface directly with the system databases, but with a relational

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database management system (RDBMS) 7 employed by the system, namely Informix The world of the wife word of the contraction of Online version 7.13. G

The Monthly Frame Relay and ATM Statistics are derived from the Daily Frame Relay and ATM summarizations already contained in the SIB 4. This is indicated in Figure 2 with the asterisk (\*). Figure 3 illustrates the process flow of this data as it relates to the daily processing of the system Data are warm about the control was a second processing

The Data Management Framework consists of a database monitoring tool, load and unload utilities, and several scripts that employ the load and unload utilities in order to migrate and summarize data between the various databases. The monitoring component utilizes the Network Interface keep alive process and the monitoring tool's output is logged in a Network Interface Logging Tool compatible format 8. The advantages of doing so are that the logging interface is common between the database and network interface frameworks, and the ability to reuse coded and tested tools is provided. The load and unload utilities also use the log tool format to post all operational and alert

messages, as do the utility scripts.

The role of the monitoring tool bis to ensure that the system databases do not exceed predefined space utilization thresholds; that the System databases remain active and available to the end users, and that the Informix Online specific event log file (typically called online log) does not grow too large. Should Sections of the System databases become too full (exceeding the threshold), a message is posted, via the log tool, to the

dr.System Administrator:(not/shown): bas subsychated at the

If; for some reason, the System databases are in an unavailable state (due to Informix Online being brought off-line), the monitor 1 will make several attempts to restart Informix Online and will again post an afert to the System Administrator stating that

Informix Online is off-line and it (the monitor) is attempting to restart it. When the Informix specific event log file exceeds the predefined size that the monitor is gauging it against, the monitor 1 will remove log file entries (checkpoint notification messages only), starting with the oldest ones, until the log file again fits within a specified Commen size range.

These monitoring functions provide the System Administrator with more freedom, as less 30 manual checking of the System Databases status is necessary: Additionally, the monitor promotes greater System database availability as the most common database operationstopping difficulty, namely running out of space, is monitored and alerts are sent in anticipation of a problem occurring, not just in response to one.

The Director 5 (the Network Interface keep alive process) ensures that the database 35 monitor (ckdbmon) 1 is started and remains active. The ckdbmon, in turn, ensures that the database management system 7 (Informix Online) remains active. Ckdbmon 1 will

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			Online when the Direc		sage is
			and the second series		
	lnformix <sub>i</sub> may only	be brought off-line	by the Administrator e	xplicitly issuing the	e valid
5 1	lnformix command	ds ( <i>onmode -uy</i> ; follo	wed by onmode -ky). I	nformix is immune	to the
I	Director's shutdow	vn commands, and ca	nnot be brought off-lin	ne by ckdbmon, so	that the
₽ <b>.</b>	System databases j	may remain on-line,	and available, even if t	he Director or ckdl	bmon
	should experience	difficulties and shutd	own. The lower action	5 (35). N. in Survivi	
Į	Figure 3 illustrates	an example of an ob	ject model in accordar	ice with the inventi-	on. In
10 F	igure 3, the objec	tentities are defined	as follows.	Albires e librar	
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Child of: Customer via Customer id number, Contract via Contract id number, Service Profile via Service Profile id number.

# Historical Service

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A service is anything that the service provider determines that customers wish to purchase and that the service provider is willing to supply. A Historical Service record contains information that was current until the associated customer, contract, or service profile changed.

Child of: Customer via Customer id number, Contract via Contract id number, Service Profile via Service Profile id number.

Contact

A Contact unambiguously identifies a person who carries out a role associated with a specific service entity (Customer, Contract, Current Service).

Child of: Customer, Contract, Current Service via service entity id number, Person via Person id number.

# Service Component

A service component is any network entity that is used within a service offered to a customer. Each service can consist of one or more service components. At the time of the network entity creation, the service component will not be related to any service. It may be assigned to a service at a later time.

Parent to: Frame Relay PVC, Frame Relay CTP, ATM PVC, ATM CTP, TDM Circuit, TDM NI, Service Information, Events, Current State, Old State via Service Component id number.

Child of: Current Service via Service id number.

#### Service Profile

A service profile describes the characteristics of a specific service or group of services.

Parent to: Current Service, Historical Service, Valid Service Component, Service Profile Threshold via Service Profile id number.

# Valid Service Components

A description of each Valid Service Component that can be associated with a Service Profile.

Child of: Service Profile via Service Profile id number.

### Service Profile Threshold

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and redmin Service Profile Thresholds are SLA thresholds that are associated with a Service Profile.

Child of: Service Profile via Service Profile id number.

# Administrative Entities

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A role identifies all the actions, with respect to the System, that a user in a specific job function is permitted to perform.

Parent to: User, Entity Access via Role id number.

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A user is a communicating entity which is registered in the Resolve Databases for the purpose of performing tasks with the Resolve System.

Parent to: Audit Entry via User id number. Additionally, all creation of and modifications to Customers, Contracts, Current Services, Historical Services, Service Profiles, Network Entities (PVC's, CTP's, NI, etc.), Roles, Persons can be performed by Limited to the control of the security of the control of the contr

Child of: Person via Person id number, Role via Role id number.

No and Calcimit Dec. (1)

surit crit fil. assesson ou al. viscala m A person is a specific individual. All Contacts must be Persons. All Users must be Persons.

Parent to: Contact, User via Person id number.

THE TEAT OF METERS AND THE PROPERTY OF THE PRO

An audit entry is generated each time user performs an operation. This entry contains references to the user, the action performed, the type of entity operated on, and the time the operation occurred. Child of: User via User id number, Valid Entity Operations via Entity/Operation number.

30 Entity Access Control Institution of the Control of the Control

This entity is used to define what operations, on what entity, are permitted for a given role. One instance of this record is created for each entity to which a specific role has privileges on.

Child of Role via Role id number, Valid Entity Operations via

Valid Entity Operations

Similarity differ in the Larte

This entity is used to define valid operation and entity combinations for the Resolve System. These combinations are then and its visites that the used to assign Entity Access to Roles, and to create Audit multiple CTP's information.

540 A. A. A. C. Parent to: Audit Entry, Entity Access Control via Entity/Operation number.

# Network Entities will be did between the company

Little Buch to the

### The FR PVC has no care for marina fortize a

Frame Relay Permanent Virtual Circuit.

Parent to: FR'NP, FR CTP via Network Entity id number. Child of: Service Component via Network Entity id number.

# FRICTP. 1975 Mary 1881 Post of the Maria

Frame Relay Circuit Termination Point. A FR PVC will have two or more (two in this release) Termination Points. Future services, such as multicast connections will have multiple CTP's.

Child of: FR PVC, Service Component via Circuit id number.

racial is

### FR NP

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Frame Relay Network Performance. This entity consists of network performance statistics collected from each FR PVC path end.

Parent to: FR PV@ Daily NP, FR PVC Monthly NP via FR PVC id minimber, and Path End id number.

Child of: FR PVC via FR PVC id number.

### FR PVC Daily NP prizate at M mobivid smill

FR PVC Daily Network Performance. Daily summarization of FR 250 drung La world drown of PVC Network Performance 11.00

Child of: FR NP via FR PVC id number, and Path End id number.

## FRPVC Monthly NPosici Land merelvice agric

FR Monthly Network Performance. Monthly summarization of FR PVC Network Performance

Child of: FR NP via FR PVC id number, and Path End id number. An Everais indicated discribing at oncease a local transfer

# and proceedings a regard and wife and

Asynchronous Transfer Mode Permanent Virtual Circuit.

TO HAND DO MADE TO THE Phrent to ATM NP, ATM CTP via Network Entity id number.

Child of: Service Component via Network Entity id number.

### ATM CTP

	tra bae maire	Asynchronous Transfer Mode Circuit Termination P	Point An ATM
. 1		PVC will have two or more (two in this release) Ter	-
		Points, Future services, such as multicast connection	
		multiple CTP's.	is will liave
5		•	t id mumban
11 ) ( 1.1. je.	ATM NP	Child of: ATM PVC, Service Component via Circui	t ia number.
	AIMINE	A complete a construction of the Control of the Con	TIL .
		Asynchronous Transfer Mode Network Performance	
		consists of network performance statistics collected	from each
	•	ATM PYC path end Promise	
	•	Parent to: ATM PVC Daily NR, ATM PVC Monthl	y NP via ATM
<u>्र</u> 	THE WAY TO SHAPE	PVC id number, and Path End id number.	
		Child of: ATM PVC via ATM PVC id number,	
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	•	ATM PVC Daily Network Performance. Daily sumr	narization of
15	more and, etc. Tippin	ATM PVC Network Performance.	214
4.35	Charles and	Child of: ATM NP via ATM PVC id number, and Pa	ath End id-
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20 7	F Safetan J	ATM PVC Network Performance.	
		Child of FR NP via FR PVG id number, and Path E	nd id number.
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		Time Division Multiplexing Circuit 17 1 197	
AT 10 m. 1	า สามอดการ (ไรสี แม่	R. Parent to: TDM:NI via Network Entity id number.	
25		Child of Service Component via Network Entity id	number.
not all la	TDM NI	CHO of the NY SEER PVC HA	
	,	Time Division Multiplexing Network Interface.	
A Tarka	่งอ่างของการสหรับเ	Child of TDM Circuit; Service Component via TDN	A Circuit id
	·	numbersatriotes a Provide N D 18	-
30,0	Event rode	Cit'd of EKNP na FR PVC Hin	i*.
	-	An Event is information describing an occurrence or	the network
		entity for which a report is required.	
	imorii. IsarriV arostus	Parent to Current State, Old State via Event id num	ber.
		, Child of: Service Component via Network Entity id	
		Child of Service Comparent vi.	
		TO NEW COMMENS	•
		· ·	

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The Current State of each Service Component is described. The Event id number links this entity to the Event which caused the Service Component to be in its Current State.

Child of: Service Component via Network Entity id number, Event Wia Event id number. Miller J. Miller

# Old State Medical way May 1963 P. C.O. By Last

le**15**. et. o etna i

Previous states of each Network Entity. This entity also describes the duration of time (in seconds) that the Network Entity was in a particular state. Separticular state.

Child of: Service Component via Network Entity id number, Event via Event id number.

# FR PVC Daily QOS and the page of the concessions

FR PVC Daily Quality of Service. This entity describes the quality of service provided, for each Frame Relay PVC Network Entity, with respect to availability time, outage time, etc. on a daily basis. The QOS statistics are derived from the data contained in the Old Line Stafe entity: The Williams

Child of Old State via Network Entity id number.

# FR PVC Monthly OOS 120 120 and as increased.

FR PVC Monthly Quality of Service. This entity describes the quality of service provided, for each Frame Relay PVC Network Entity, with respect to availability time, outage time, etc. on a a to sense of the first monthly basis. The QOS statistics are derived from the data contained in the Old State entity.

25 are tron to a 102 Ave to Child of Old State via Network Entity id number.

# ATM PVC Daily QOS and blook T of all air sq [1

ATM PVC Daily Quality of Service. This entity describes the and the state of the service provided, for each Asynchronous Transfer Mode PVC Network Entity, with respect to availability time, outage time, etc. on a daily casis. The QOS statistics are derived from the data

contained in the Old State entity. (1979) (AP)

Child of: Old State via Network Entity id number. Cherry top et

### ATM PVC Monthly QOS

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ATM PVC Monthly Quality of Service. This entity describes the quality of service provided, for each Asynchronous Transfer Mode PVC:Network Entity, with respect to availability time, outage time, etc. on a monthly basis. The QOS statistics are derived from the data contained in the Old State entity. Child of: Old State via Network Entity id number.

# TDM, Daily QOS VICES CLEAR IN THE BOLL OF THE BOLL OF

TDM Daily Quality of Service. This entity describes the quality of service provided, for each Time Division Multiplexing Circuit Network Entity, with respect to availability time, outage time, etc. on a daily basis. The QOS statistics are derived from the data contained in the Old State entity. Child of: Old State via Network Entity id number.

## TDM Monthly QOS

TDM Monthly Quality of Service. This entity describes the quality of service provided, for each Time Division Multiplexing Circuit Network Entity, with respect to availability time, outage time, etc. on a monthly basis. The QOS statistics are derived from the data contained in the Old State entity. The AME TO A VIEW

20 Child of: Old State via Network Entity id number.

# System Entities, 47 . so 100 loss two 100 lyres in writing .

# Line the Service Info-; gridentians of reason at militaria.

3 3. 3 13 34

This entity is used as an attach point for addition description information relating to the Network Entities.

> Child of: Service Component via Network Entity id number, Info Type via Info Type id number, A half (1996) is 12.

# ATM AND Dutin Calliny of Several page Type Tables of Several

This entity is used to specify the type of service information that can be associated with each Network Entity.

30 miles and the same some Parent to: Service Info via Info Type id number.

# Stat Collector Information and School and an Earth of the

This entity contains information regarding each set of statistics that is collected. SOC Without D'ON TO S

### **Event Collector Info**

35 This entity contains information regarding each event collection session.

### 46020 Event Translation

25

This entity maps 46020 events to Resolve events.

# 46020 Stat Translation

This entity maps 46020 statistics to Resolve statistics and indicates which statistics should be gathered for the Resolve Databases.

THE TRYE

### 1.5 mg and 1.46020 CallAtt Translation and Building the and burger made.

This entity maps 46020 objects to Resolve Network Entities. This includes the ability to map more than one Network Management

# to the late of Table Version Info consequence to 201 had distributed by the two sections of

This entity is used to track the version of each physical table in the Resolve Databases. This table ensures that incorrect versions of data are not restored.

# Carlo, Con Archive Info full pead of a received adverse me and the arm fat

This entity tracks all Resolve archives, both full database backups of the SMIB and SIB, and daily table backups within the HIB.

# s of thomas of an iDBSpace Usage is an other ord substitution of a contraction of the contraction of the first

This entity keeps track of all the dbspaces available and in use in the Resolve Databases. This entity is used to maintain the large inflow and outflow of data to the HIB.

.3 20

The Physical Database Design is the physical, or actual, representation of the Object Model and Logical Database Design. In most instances, the physical design maps quite closely to the logical design, but some deviations may be to achieve greater response performance, or to take advantage of additional features of the RDBMS employed, or to accommodate a lack of required features in the RDBMS.

the maintainment to be start in was effected field. The safe it was and

The SMIB 2 is an operational data store. It contains both 'soft data' data (customer, contract, SLA) that can be derived from other Service Provider systems, and data that is in a constant state of flux - Service and Service Component data.

The SMIB 2 is the definitive source from which to derive inventory and status reports on the Networks, the impact on Service Provider Customers, and the appropriate individuals a second contact with respect to Network events.

Due to the fact that a sizable portion of the SMIB's data is changed daily, the SMIB is enabled as a transaction logging database. That is, any changes made to the SMIB are not only stored in the database, but also recorded in transaction logs that can be replayed in the event that disaster recovery is necessitated, thus the SMIB can be recovered up to its

most recent update

Note that the data contained in the Events, Current State, and Old State entities is only a single days worth. This data is migrated, nightly, to the HIB. The SMIB is shown in Figure 4.

The HIB 3, shown in Figure 5, is a very large store of data. It contains Network Events, the corresponding Network Entity states, and the Network Performance Statistics for all the Network Entities that are currently being tracked (as indicated in the SMIB). By volume of data, the HIB is approximately 40 to 50 times larger.

In the simplest sense, the HIB is a data warehouse. It contains very large volumes of data, covering the same Network Entities over a period of time (60 days, in the case of Resolve 10, 1.0), and the data is never updated by end users, or by connecting systems.

The HIB is NOT a data-warehouse from the view that it does not contain data brought together from multiple heterogeneous data sources, but this is a discussion that is of little relevance to this document. Suffice to say, that the HIB contains a very large volume of data that is quite static in nature.

- The daily Events, Current States, and Old States are migrated to the HIB from the SMIB nightly, and the Network Performance Statistics are loaded; from flat files (created by the Network Interface Stats Collectors see Resolve Release 1.0 "Architect" Network Interface for 46020 Detailed Functional Specification: reference [8]) into the HIB nightly.
- The data in the HIB is held on-line (within the active database) for a period of 60 days, and is then purged. It is however, saved on tape; and may be recovered for additional analysis with the assistance of the Resolve Administrator.

Unlike the SMIB 2, the HIB 3 does not employ transaction logging, meaning that the HIB

cannot be recovered to the most recent point in time. Recovery to the most recent point in

time, however, is not necessary as the HIB does not permit user updates against it. Since

the only updates are performed by nightly processes, the new data added to the HIB daily

is archived to tape by one of these processes. Thus, any disaster recovery may be

performed by the Resolve Administrator using the daily data that has been archived to

30 The SIB 4 contains the end product of all the data collection and processing efforts. It is here that the end users of Resolve 1.0 may most easily extract meaningful information.

All the information in the SIB is summarized and processed data extracted from the HIB.

The processes to create SIB information may be customized to suit a particular Service

is by storic in the database, but also recorded in teacts to be by the traditional policies. Proping Parties the content of th

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The information in the SIB, like that of the HIB, is static in nature as it is not updated or modified by users or processes. Because of its condensed nature (a single days worth of statistics for one service component equates to 96 records in the HIB, but only one record in the SIB), the SIB can present information covering a broader time period (180 days).

The Quality of Service entities are derived from Old State data in the HIB, and the Network Performance Statistics are summarizations of Network Performance Statistics in the HIB.

Like the HIB 3, the SIB 4 does not employ transaction logging. It does however, have regular backups of the entire SIB made. In the event of a disaster, the Resolve

Administrator could restore the SIB back to its current state by restoring the most recent backup.

The SIB 4, shown in Figure 6, contains the end product of all the data collection and processing efforts. It is here that the end users of may most easily extract meaningful information. All the information in the SIB is summarized and processed data extracted from the HIB. The processes to create SIB information may be customized to suit a particular Service Provider.

The information in the SIB, like that of the HIB, is static in nature as it is not updated or modified by users or processes. Because of its condensed nature (a single days worth of statistics for one service component equates to 96 records in the HIB, but only one record in the SIB), the SIB can present information covering a broader time period (180 days). The Quality of Service entities are derived from Old State data in the HIB, and the Network Performance Statistics are summarizations of Network Performance Statistics in the HIB.

Like the HIB, the SIB does not employ transaction logging. It does however, have regular 25 backups of the entire SIB made. In the event of a disaster, the Resolve Administrator could restore the SIB back to its current state by restoring the most recent backup.

was performed to 1000000 and 200. Again, this ASCII this constant of  $\epsilon$  and  $\epsilon$  and  $\epsilon$  , find

The operation of the system will now be described. When the database server is started (or restarted), the instance of the Director on the server starts a ckdbmon process for each instance of Informix Online that exists on that server. That is, if two Informix Online servers are running on the same workstation (this is a distinct possibility), two instances of ckdbmon will be started. Each instance of ckdbmon will start its own instance of the ckdbmon log tool 8 (ckdblog) in the start of the ckdbmon log tool 8 (ckdblog) in the start of the ckdbmon log tool 8 (ckdblog).

Additionally, the cron table is set so that regularly scheduled database jobs are initiated.

These jobs are run nightly and accomplish the task of migrating data from the SMIB 2 to the HIB 3, and summarizing the data in the HIB 3 and deriving quality of service (QoS) information, and statistical summaries, and placing this information in the SIB 4. Other

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nightly jobs, archive the data collected daily for the HIB 3 and store it for future reference in an AIB (Archive Information Base). Figure 2-3 describes the nightly flow of data and the high-level processes involved in this flow of data. Lastly, utilities to remove old data from the HIB and SIB, and to restore old, archived data from the AIB to the HIB 3 and SIB 4 are provided. A PAD more lawner and the section of the secti

With this feature network statistical data that can reach volumes of up to 600 million rows in a single table at one time. Obviously, a table of such proportions would require some indexing or searching for specific data within it would be a tiresome and time consuming task. Conversely, attempting to load an additional 1 million records into this table, having an index, could take days; as the amount of time required to load data into an indexed table grows exponentially with respect to the volume of data already in the table. In order to avoid this costly operation, a new work table is created, with the same structure as the table containing all the existing data; but without any indexes. Data is loaded at a much faster rate (the amount of time required to load data into a non-indexed 15 table is a linear-function, with the constant being very close to 1 4 that is the number of records by a set factor of time). Figure 4 illustrates the use of table fragmentation as it is employed by the System Database Management Framework. Data is loaded, from an ASCII delimited flat file into the temporary working table, that

has been created in its own dbspace (1). One days worth of data is loaded into each 20 dbspace. Once this work table has been loaded, advantage can be taken of its smaller size, relative to the larger HIB data table (1 million rows vs. 600 million rows for stats), and the fact that it contains a single full days worth of data (a day is the smallest unit that the SIB data is summarized on), to perform any summarizations or quality of service (QoS) derivations to be loaded into the SIB on this work table. The latest personal in

25 In addition, the original ASCII delimited file is archived in the AIB (2), and this fact recorded in the SMIB, so that this data can be re-examined even after it has been aged and purged from the HIB and SIB. Again, this ASCII file contains one full days worth of data. The aged data that currently exists in the HIB dan be easily removed by simply detaching the dbspace that contains that particular days worth of data from the main table and then 30 reduces the time that would be required if the data were to be deleted directly from the main table (the dbspace that has just been cleared of aged data can then be reused as the work dbspace) Historica and firm a Finally, the work table is attached to the main table and the indexes on the main table are

rebuilt - but only the portions of the index relating to the newly attached data.

Table fragmentation, that is the actual data in a fragmented table can be separated, using (300) some of three methods; who have all the in a subject gristen recursions. The many the

a for the manufact summands and placing this mornation in the Mill 4. Other

- 1. Expression Based Fragmentation all data is placed in a dispace based on a expression involving a column or columns within the table (e.g. a table containing phone numbers may be fragmented using expressions based on ranges of area codes).
  - Hash Fragmentation a unique, or key column in the fragmented table is put through a hashing formula to determine which dbspace that particular record should reside in.
    - 3. Round Robin all data that is inserted into the fragmented table is distributed evenly across all dbspaces in the fragmented table.
- An interesting characteristic about the Round Robin method is that any data that is in a dbspace that is attached to a fragmented table (vs. being inserted directly into the fragmented table), is not redistributed to other dbspaces within the fragmented table. This means that as long as the System utilities do not insert data directly into the main, fragmented tables in the HIB, but instead, create work tables and load them and attach
- 15 them to the main fragmented tables, it is possible to know exactly which dbspace contains a particular days worth of data.
  - While the same statement is true when using the other two fragmentation methods, both of those require the Informix engine to check each row of data in both the fragmented main table and the work table prior to allowing the attach to take place. Conversely, no
  - row checking is done when performing an attach operation using the Round Robin method. The difference between Round Robin and Expression Based fragmentation, in the time required to perform an attach operation, is huge. Therefore the Data Management Framework uses Round Robin fragmentation, and the rule that no data may be directly inserted into a main table in the HIB is strictly enforced.
  - 25 Each of the main data tables in the HIB (events, old states, FR Network Performance, and ATM Network Performance) are fragmented using Round Robin fragmentation, and each has a finite number of dbspaces dedicated to it. Typically, there are 60 dbspaces per table, for 60 days worth of data, and an additional 15 dbspaces for the retrieval of historical data that has already been removed from the HIB and now resides only in the AIB.
  - Since the row size and the number of records per day varies between the tables in the
    HIB; the dbspace sizes are different for each table. This necessitates that the each dbspace is dedicated to one and only one table.
    - Because the system HIB only stores a finite number of days worth of data; the dbspaces for each table can be recycled, with old aged data being removed and new data being
  - added using the same dbspace. Figures 7 29 demonstrate how this is performed from a dbspace usage level, but to added the form to the form

The table salled dbspace usage is a table in the SMIB (the actual name is txd\_dbspaceusage). This table is used by the utilities loadhib event, loadhib ostate, loadhib\_frnp, and loadhib\_atmnp, and it allows these utilities to identify the dbspace that contains data that is a particular age (in the example, 60 days old), to remove that data by detaching the dbspace, and then load the new data into that dbspace, and update the dbspace usage table (Figure 3-4);

> The SMIB is the operational data store of the system Databases. This means that the data contained in it is timely and can change frequently.

In order to keep track of current network path (or network entity) status, the operational 10 and administrative states of each path, as well as the events that caused a path to be in that state, are recorded in the SMIB. Event data is stored in the tev event table, while the current state of each path is stored in the tcs\_currstate table. Querying the current state table will allow the user to build up-to-the-minute inventory reports of available paths, and operational reports of path status'.

Since this state information is also required to derive long term availability information -::<sub>S</sub> · 1.5 (used to measure compliance to service level agreements), the non-current, or 'old' state data is also saved and maintained (this is stored in the tos oldstate table). Within the SMIB, each time the state of a path is updated (in the current state table) a database trigger (add\_state\_rec) creates a new record in the old state table indicating the old states of the path, the time that it originally entered that state, and the amount of time (in seconds) it remained in that state. The seconds is the seconds of the seconds. 

All of this data (the events and states) is migrated nightly to the HIB as it quickly changes from being critical, timely information, to data that can be used to track SLA compliance. Beinellen visites et S. H. ed. at Master E. F., ozer be Cart

Since events are constantly occurring, and it is necessary to keep the events, current state, and old state tables synchronized; a suspend collection signal is sent to the events collectors, via the Network Interface Director's interface process called RCI. This suspend\_collection signal will cause the events collectors to stop inserting new events into the SMIB and instead, store those events in buffers until the previous days worth of events and old state records can be removed from the SMIB. At that point a resume collection signal is sent, via RCI to the Director and, to the events collectors, and normal processing resumes, with any buffered events being processed first. Figure 11 is a simple timeline demonstrating the various combinations of events and states (with respect to start and completion times) that may exist in the events table in the 35 SMIB. Events 0 and 1 occurred prior to the day that is being processed (October 10,

1996), but the state that events 0 and 1 placed paths 0 and 1 in respectively, continued into the processed day. Event 2 placed path 2 in a state that both started and completed (at

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Event 2') within the processing day. Event 3 occurred in the processing day, but the state of path 3, caused by event 3, continued into the next (the current) day, as did the state that is weight 0 placed path 0 in. The state of the second of t

Since the SIB reports on summarization's in strict one day intervals, and since the HIB 5 contains all data that is one day old or older, from Figure 8, it is apparent that a method to include those events that are still current (the state has not changed yet), but that occurred prior to the current day must be devised.

The strategy, as implemented in the System Database script unload\_smib, is to add a column onto the end of each old state record in the old state tables in both the SMIB and HIB. This column, called the partial column, contains a 0 if the record has been completed prior to the end of the previous processing day (midnight) - the states caused by events 1 and 2, in Figure 8, fall into this category if processing for October 10, 1996 is being performed (as expected) in the early morning of October 11, 1996.

Any events in which the state is still current, as is the case with states 0-0' and 3-3', in Figure 11 (as derived by joining the events table with the current state table) will have that current state placed in the old state table, but be indicated as partial by placing a value of 1 in the partial column of the old state table. The current state records (relating to events 0 and 3) will remain in the SMIB, as will the matching event records (events 0 and 3), but a record of the event that caused the current state, and the duration, up until midnight, is now recorded and moved to the HIB. Since states that do not complete prior to midnight processing are placed in the HIB as partial records, these records must be replaced with either a new partial records or completed records the next processing period. Thus, full data, up until 12:00am of the current day is available in the HIB, and data integrity is insured as the partial records are updated or replaced. This is shown in the 25 tables below. Caralla a 192 FIO francisco de Alberta Caralla

Events	Current State	Old State	
the college and exercise with the	Pathld State time Eventld	Pathld Eventld time State Duratio	n Partial
	TOCOTCO, BBLOTES A COLOR	118 Full English Digital Change	
2 / pre2 - tpre2 B / esc. 3 3 13 A	3 A B 3	70/10/20 20/20 17 19 10 10 10 10 10 10 10 10 10 10 10 10 10	3 0
- [[[/ ]] 6:[[[[]] 2]] [[[] 2 1 2 1 2 1 2 1 4 1 4 1 4 1 1 2 1	ted records firm, the mov	pre2 tpre2 B t2-tpre	2 0
1 1' tl' B	1 B U' I'	1 1 tl A tl'-tl 2 2 2 2 4 A 12'-t2	0
2 " · 2' · t2' B	2 3 2' 2'	2 2 2 12 A 12'-12	. 0

Pulled Figure for Followick Contents of the Events, Current State, and Old State tables in the SMIB, at 11:59pm, October 10, 1996 The Events table will contain all events that occurred either during the hours of the processing day - Oct. 10 (events 2, 3, 1', 2') or those which were current events as of 30 12:00am of the processing day (events 0, 1). Note that the old state table will only contain records of previous states that were in effect at some time during the processing day. This

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is why there are old state records relating to events pre2 and pre3 - the states pre2-2 and pre3-3 were in effect as of 12:00am, Oct. 10.

The following table illustrates the changes that occur in the old state table in the SMIB . during nightly processing, as performed by unload smib.sh. The current states of the paths are written to the old state table as partial records with duration's calculated to midnight of the processing day.

			•••		
	Pathld Eventid	time	State	Duration	Partial 0
	3 pre3	tpre3	B.	t3-tpre3	0
	, 2 . pre2 .	tpre2	В	t2-tpre2	0
i dali di Eliai :	0. 7. 0	- 10	Α	midnight Oc	t.10 - t0 1
	$\frac{1}{3}$ and $\frac{1}{3}$ .	=, t1	Α	tl'-tl	0
***	3 3	t3	A'	midnight Oc	t.10 - t3 ' ' ' ' ' ' ' ' ' ' ' ' '
	2 2	<sub>-</sub> 12	, <b>Α</b> .	12 -12	
** ** * * * * * *	, 1 , 11,,	'tl'	B.	midnight Öc	t.10 - t1' 1
100000000000000000000000000000000000000	2 2'.	ن <b>(2'</b> ن	В	midnight Oc	L10 - (2' 💆 (1 🚛

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Partial Records placed in the SMIB Old State table during unload smib.sh processing All old state and event records which have a timestamp of a day prior to the current day -10 Oct. 11 (states 0-0', 1-1', 2-2', and 3-3', and events 0, 1, 2, 3, 1', and 2') will be copied into ASCII delimited files for loading into the HIB, and all non-current event (events 0, 1, 2, and 3) and all old state records (states 0-midnight Oct > 10, 1-1', 2-2', 3-midnight Oct. 10) will be deleted from the SMIB. The following tables illustrate the state of the HIB, prior to nightly processing of Oct. 10th data, and the state of the SMIB and HIB a start of the sta

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affice at the eligible situates as filles and beautiful state of activities of the
    Pathld Eventld time EvType .... Pathld Eventld time State Duration .... Partial
```

The state of the HIB Events and Old State tables prior to unload\_smib.sh processing for Oct. 10th data Prior to loading the event and old state records into the HIB, any event records which are related to partial old state records, and the partial old state records themselves (in the event and old state tables in the HIB), are deleted. These will be replaced by either new partial records, or completed records from the most recent day prior to the current day.

```
.. Current State
                                                                                                                                                                                                                                                              Events -
                                                                                                                                                          Pathld EventId time EvType
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       PathId State time EventId
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Pathld EventId time State Duration Partial.
7 (141 0) mdo 0 0 (141 0) (140 n (140
                                                                   self to at ten 1) arthur Bio Lie berratoro B. b. alfreve the musione liev of Lie
                                     in as alreve seconds in the second record of the second se
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SMIB data in the Events, Current State, and Old State tables immediately after unload, smib.sh processing The state of Oct. 10th data and in the state of the state

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Γ	Even	ts - d	1 11	1,1	· · · · · · · ·	Old State	A training	الما ما المواقع المواقع المواقع	
Pathld	Eventle	d time	EvType	Pati	ıld Eventi	d time Sta	te Duration	Į arai	Partial
				3	pre3	tpre3 B	t3-tpre	3 <sub>170</sub>	, 0
	10 14 - 5		3.:	· · · · 2 ·	pre2	tpre2 B	t2-tpre	2	0
0 .	.0.	10	, A	t 0	; Oit.	10 A	midnight	Oct.10-10	., 1
i	i i	'tl'	Α	' ' 1'	· · · · · · · · · · · · · · · · · · ·	tl A	il'-tl		Ò
3	3	t3	Α	. 3	3 . :	£3 · A	midnight	Oct.10 - t3	.; 1
2	2	t2	Α	2	2	12 A	12'-12		. 0
1	:1'	: 11'	r. <b>B</b>	1	11/12	112 , B	midnight	Oct.10 - t1?	1
2	2,	12'	B	2	2'	t2' B	midnight midnight	Oct.10 - t2'	1
p Ē	. 16.0		, A	, a - 1 - 1	77 . 19 taa	ries h. 12	, A, 15	: L	

HIB data in the Events and Old State tables immediately after unload\_smib.sh and loadhib\_event.sh and loadhib\_ostate.sh processing of Oct, 10th data

There is one additional occurrence that must be processed in the Events and Old State tables in the SMIB. It is when there are new events, that have occurred after midnight of the processing day, but prior to the nightly processing being performed. The old state and event records of this type must be kept after the nightly processing, or the next day's processing will be inaccurate. To accommodate this occurrence, a partial type of 2 is placed on these records. They are not unloaded, nor are they deleted from the SMIB. The last step of the nightly unload\_smib process sets these partial types back to 0, after the other event and old state records have been unloaded and deleted from the SMIB. There exists, within the System Database Management Framework, the ability to restore aged data that has previously been removed, or purged, from the HIB. The principle behind this function is similar to the principle applied by the HIB storage management tracking dbspaces availability.

Each table type in the HIB (currently Events, Old States, FR Network Performance, and ATM Network Performance) has a limited number (typically 15) spare dbspaces reserved for aged data. This is data that is older that what is considered active data in the HIB (older than 60 days in this example).

The following table illustrates how the data in the dbspace usage table is applied to locate a dbspace of type event that is not currently used and is available (indicated by a NULL value in the last usage date column, and the 1 in the available column).

•	- 'DBSpace Usage Table
 **	DBSpaceName DBSpace Number Object Type Last Usage Date Available
14 .	

The second of th	dbt or	inter (≘t c <b>6</b> atdo.	The acyentic dadil	1996-10-091
4, 2 3.4 4	db2	10	event	1996-10-08 0
ng grand na atawa ji ka <mark>besta</mark> a	. db3 :: : :	1. one in 14.22	VID leventillo	1996-10-07[57] 0. [1] 31.5
	db4	18	event	1996-10-06 0
en in regional a modification	ale gas	tim or. If w beid	sias bio a di 1.	r na Seadhn a cho e a chombhra
•	. db60 .	262	event	1996-08-10 0
or on the articles are the	`db61 <sup>⊕3</sup>	333 575 7 <b>3266</b> 1333	Sage event	1996-08-10
•				i red - de braz d'Edeldorne
•		ilila e e Di IDP sats.	젖다 된 하나라의 여울시다.	The second of th

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The actual aged data ASCII delimited files are tracked by another storage management table in the SMIB call the archive information table. This table gets updated every time an archive of HIB data occurs. The type of data (events, old state, etc), the volume label of the tape or file that the ASCII file is stored on, the date of the data, and the version of the table structure (for future use) is recorded.

When a user of the System System wishes to analyze aged data, a request for the data is made to the System Administrator. The System Administrator can then use the restore script to first, select the particular data that was requested; then restore it to the HIB. When that data is restored, the dbspace usage table is updated to indicate that this data is

now in the HIB and the dbspace used is not available for other restores until this data has been removed again from the HIB. The Sale of the state of the st

.1. 11	1.118 -	J43 :		. Fr. 1L	. 1 m	1. TH 1. 1		1 1	1.17.4	
j f <sub>er</sub> odi	,db1,3∵	r⊊db2 n	3 db3()	niay. a	db58;	. db59 📑	db601,	. db61 7	™ db62	db75
	2.215.2	(See 11)		indus viit	i' - C >		2.74 3	7 1. 1.1.	nur il q	

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~ · · · · · · · · · · · · · · · · · · ·		DBSpace Usage Table	. Rubil septial folks	control of the	more containing
.a∜	DBSpaceName_DB	Space Number Object	Type Last Usage Date	Available,	and the second second
·	db! db2	6 event	1996-10-09 / 1996-10-08		1 3-11-1-11-1
91-11-1	db3	14 event	1996-10-07 JC © 1996-10-060≌™	<u>ಿ</u> ಚರ ಗಬ್ಬರೀಕು ಮು	1.6) 1 2
1.50 ( ; )	: / db60	262 event	1996-08-101	0 000 1 12 1 17 17 18 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	regel et al. 🐔
	db62	270 event		1	

# updated dbspace usage table with restored aged data

Newly aged data (data that has just become older than the active data) is automatically purged with each nightly run of the loadhib scripts. However, aged data that has been restored by the restore is not purged. This is due to the fact that the restored data was restored for further analysis and should therefore be kept in the HIB until it is no longer required. The removal of this data requires proactive steps to be taken by the System Administrator. Using the purge hib and purge sib scripts the System Administrator can list all data that is older than active data in each of the HIB and SIB respectively. purge\_hib will use the dbspace usage table to determine the number of days old the aged HIB data is relative to the current day. Once purge hib is executed, any data as old or older than the number of days old selected will be purged and the dbspace usage table will again be set in indicate that the dbspaces that were used for the purged data are now available, and the last usage date is again set to NULL. purge\_sib will scan the date values in the SIB to build of list of days of aged data. This is

a slower process, but due to the lessor volume of data in the SIB (relative to the HIB)

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performance should not be an issue. As with purge\_hib, purge\_sib will delete any data that is as old or older than the days old value passed to it.

Informix Online provides support for Referential Integrity in the form of Referential
Constraints (foreign keys). The RI constraints ensure that a child record cannot be added
if the relating value does not exist in the parent table, and conversely, that a parent record
cannot be deleted if a child record relating to it exists. These relations deal with physical
occurrences of records.

However, some entities within the System databases are related to each other on a logical level. That is, some entities (user, person, service contract, customer, etc) can be flagged as logically deleted, in which case they are no longer available for reference or manipulation via the Configuration GUI or Reporting tools, but they physically remain in the database. Since these records are not physically removed, there is no way of enforcing RI constraint rules. In response to this, what has been implemented is a set of triggers, activated upon the update of the 'deleted' indicator column in those tables, that call stored procedures that check for child records that have not been logically deleted. Table 3-1 lists-each parent table, its child tables, and the trigger that is activated upon a logical delete.

Pare	ent table	Child table	Trigger
tcu_	customer and the stage	ter_contract	process_cust_upd
tcr_c	contract	tse_currservice  tse_currservice  secondary  tco_contact	process_contr_upd
tsp	servorofile	tse currservice	process sp upd
tse_	currservice	tsc_servcomp	process_serv_upd
		tco_contact	<u> </u>
tpe_	person	tco contact	process pers_upd
tro_:	role Francis mg/ a r i baber is	tus_user tus_user tea_entityaccess	check_role_child

Data Integrity Triggers of the SMIB

Due to the very large numbers of DASD devices required for a full System, there are several files that must be customized on a per installation basis. The altering of these files can have dire consequences as they relate to the System.

1. links.sh - this file creates the symbolic links for the database that are used by Informix Online for dbspace files. This file will require that the devices linked to, and the chunks linked to each device are defined. Additionally, the symbolic links to the tape

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- devices required by the System Databases (two devices, one for log files, the other for archives) must be defined.
- onspace.sh this file creates the dbspaces on top of the symbolic links created by links.sh. The onspace commands specify not only the dbspace name and the path of the chunk supporting the dbspace, but also the bytes offset and the size of the dbspace. For this reason (specifically the offsets), onspace sh must match the links.sh file. If it does not, the installation will proceed, but the System-System will not function as some dbspaces will not be brought on-line due to incorrect space allocation (incorrect offsets).
- 3. dbspace usage sql this file calls the stored procedure, init dbspace usage, which seeds the dbspace usage table for storage management. If the system you are installing will store 60 days of active HIB data, this file does not need to be changed. However, if you plan on storing more days or less days of HIB data, the first parameter in each execute procedure statement must be updated to reflect this.
  - 4. storage.cfg this file indicates where files are located, names of system tables, and the number of days of HIB and SIB data to be stored. If the number of days of HIB data stored is not 60, or the number of days of SIB data to be stored is not 180, this file must be updated to reflect this.

When the System Database is first installed, it is prepared, and expects, to accept data immediately. Conversely, if data is not submitted to the HIB processes for a period of time immediately after the system has been installed, The Data Management Framework processes will automatically perform the necessary alterations to ensure smooth operation.

Descriptors are used in the system as more fully described with reference to Figures 13 to

Figure 13 is an overview of the object models for a TIM (Telecom Information Management) architecture.

Figure 14 shows the types of descriptors that are provided in a typical system for managing service level agreements. There is a top level descriptor, and derived descriptors relating to various aspects of the system.

The top level descriptor stores meta information on entities. The base class provides a template where unique lds, names and descriptions are stored. The derived classes define additional qualities for specific descriptors.

In a service level management system, the use of descriptors enables new service level agreement thresholds to be added to the system without modifying the service profile code. For example:

Export Control: Public

rega**.Cardinality** in the property of the contract of the case of populierarchy: Commence of the state of the contact of the state of th The state of the Superclasses. None who are a solutions of the state o Private Interface to the company of the control of Attributes: year to many efficient to measure of the angle of artists and their per enjoyed on the man matter shorts of an are stroke and instance of the control of The descriptor uniquely identifies the descriptor record Apparent to the bill be taken a promattached to a specific class. We discuss the bill be a second of t instrumentary of an in the second Name:char[200] The descriptor name is the unique name of a 10 descriptor Description :char[200] The description is a brief summary of the purpose of the descriptor 15 State Machine: No Concurrency . Sequential Persistence Persistent In Figure 15, the classes in the top layer object model of Figure 14 are defined as follows. Class name: Descriptor professional professional for 20 Documentation: Whatest and Aren was This class is used to store meta information on entities. The base class provides a template where unique IDs, names and descriptions are stored. Derived classes are used to define additional qualities for specific descriptors. The intent behind the Descriptor 25 concept is to minimize the impact of adding new functionality on critical parts of the system. For example, new SLA thresholds can be added to the system without modifying the Service Profile code. Superclasses: and of intermed them are all beautiful of polynomial and a significant to a <none> े वे े वेरे पर व्योग एक वेस्त्रवाचा वाद बाद द्वीदेखे. Roles/Associations: 30 1400 ATA 是为180 <none> FOR ENTER A COLD CONTROL OF MEDI 2! Attributes: Here interpreted and for OLA therebydes at the inner type: short with the first of the second section of the second section of the second The descriptorId uniquely identifies the descriptor record attached to a specific class. name: char[80] action MC MTA gains between as bestitum source on M. The descriptorName is the unique name of a descriptor. description: char[200]

4.1.

Figure 16 also illustrates how descriptors are used to dynamically add new capabilities to the system. As new entities or operations on entities are defined and implemented, new entity operation descriptors are defined and added. When these descriptors are added, the user management module becomes aware of these capabilities. The user management module is used to give/deny access to specific parts of the system.

Each instance of a descriptor sources its information from a specific row in a relational database table. The following table illustrates the instance data associated with the service component descriptors for use in a system for managing service level agreements in a telecommunications network. 

## 10 Service Component Descriptor

	Туре	Name	nextDescription
	0	Undefined	Undefined Service Component.
S. S. Carlotte	1; 7,	TDM Path	A logical end to end connection implemented using
	$\sim$	•	time division multiplex (TDM) technology.
	2	FR PVC	A frame relay path. A permanent virtual end-to-end
			connection implemented with frame relay technology.
	3	ATM VCC	A virtual channel connection. A collection of
.હાર હેલા કા	ot ditte.		connections that form an end-to-end path through a
	-		network
	4	ATM VPC	A virtual path connection (VPC). A logical
			communication channel that is available across the
	ar izva,	lit Longton il	physical ATM interface and that can carry one or more
			ten enologi <b>virtual channels.</b> All populus evel e etaliques
			The total Art TDM Network Interface from the first of the
			Circuit Termination Point. 1997
ئے افتد ''ڈائی کائی	7	ATM CTP:	tables so a ATM Circuit Termination Point.

If, for example, the service provider receives a requirement to support ATM UNI services, The following new descriptors are added.

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Entity → ATM UNI

15 Service Component → ATM UNI

New descriptors are added for SLA thresholds, and statistics.

New valid operations instances are created for ATM UNI. No software is required to change in the user / security management module.

New service profiles can be created using ATM UNI without any modifications to the software in this critical area ಗಾರವಾದ ಕರ್ 20 are the same of its areligate to the site

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New services can be configured with ATM UNI service components assigned to San Pleton Live Control them.

Within the configurator, the only software modifications required are new screens to view details associated with the ATM UNI.

The service definition layer is shown in Figure 17. ైనాని ఎకెడ్డిని చేసినికి Class name:

### Descriptor

Documentation: [15]

This class is used to store meta information on entities. The base class provides a template where unique IDs, names and descriptions are stored. Derived classes are used to 10 define additional qualities for specific descriptors. The intent behind the Descriptor concept is to minimize the impact of adding new functionality on critical parts of the system. For example, new SLA thresholds can be added to the system without modifying the Service Profile code.

Superclasses: 15

<none>

Roles/Associations:

<none>

Attributes: 3 50 . 350. 20 . 1 . 1 . 2 for a for a top to be of a 2 for a common of A

type: short - main will its a wild main dismodule for a compare 20

The descriptorId uniquely identifies the descriptor record attached to a specific class.

nations is a confident Couract Bress, 1995 Three

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name: char[80]

The descriptorName is the unique name of a descriptor.

description : char[200]

The description is a brief summary of the purpose of the descriptor. 25

Has-A Relationships:

<none>

Operations:

<none>

30 Class name:

### ServiceEntity

Documentation:

Service entities are the base components of service model, representing the customer, the contracts owned by that customer, the services contained within the contract, and the The water was a first and a measurement

is the base value for the threshold. The value can be contented

service profiles desribing the services. 35

Superclasses:

Entity this is not need with this mental feed on the about the first training as on but

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To stability of each or animal of the re-

responsibleFor in association Contact ServiceEntity collectedBy in association-ServiceEntity\_UserLogEntry Attributes: the articles associated in the AT

whoCreated: integer

The ID of the user who created the entity.

whoLastModified: integer

The ID of the user who last modified the entity. If the deleted flag is set this attribute holds the id of the user who deleted the entity:

Has-A Relationships:

Snone to the most of the second of the secon

Operations:

15

Delete() The deletion of a service entity will be tracked as a modification with the result of the delete flag being set.

Class name:

### **SLAThresholdDescriptor**

Documentation:

A template for a Threshold object that defines the characteristics and description but not the specific value of the threshold. An SLA threshold descriptor must be created for each 20 new threshold type that the system will support. Superclasses:

ly descript fixame is the enjoyed and a of a descriptor

Descriptor

Roles/Associations:

25 measures in association ContractThresh\_SLAThresh mapsTo in association SLAThresh ServProfThresh Attributes:

defaultValue: double

A default value for the threshold. The value can be customized in each instance of the 30 SLAThreshold. Service Indev

serviceCompDescType: short

Foreign key to the type of service component this threshold can apply to. units : char[40] and Laterday lead may be a color beautiful the contract of the

Description of the unit of measurement. 25 physics and galidance and to washe 35 relatedClass: short Indicates whether this is a contract related threshold, or a service profile related threshold.

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	Has-A Relationships:	CONTAINER OF VIOLE	
	<none></none>	151 (12 एस - ५००) एउन की पुरासी के क्वेंग है।	
	Operations:	mg skillt literitä	
	<none></none>	องเหมืองทัด ของสมสังกระทำสาร	٠
5	Class name:	transport Turker (	
<del>.</del>	FunctionDescriptor	Local Bible State of the Company of the	
	Documentation:	5 35 5 F 4 10 4 10 15 1	
	This class is used to enumerate the descri	iptions of functions or job roles that can	be
	associated with a contact person within the	he system. A Function descriptor must b	e created
10	for each new function that the system wi	ll support.	11
	Superclasses:		
	Descriptor		
	Roles/Associations:	500	
	performs in association Contact_Function		
15	Attributes:	London (Control on Control	21
	<none></none>	estata de maria	
'	Has-A Relationships:	NI CATE OF THE STATE OF THE RESERVE	
Ti t	, ,	នៅសេច <i>មា</i> ស្រាស់ (18.15) បានស្រែក 20.	
٠	Operations: (2) 1945. Land Control of Calculations		
20	<pre><none> / fig.dl for return figure up to</none></pre>		• .
	Class name: - 1" in sent of the and set		
٠	Contact [2013] Migramoquia mensamma (		
	Documentation:	5195 B 7795 B 795	
	A Contact unambiguously identifies a pe	erson who carries out a role associated w	ith a
25	specific Service Entity. The class provides the necessary information to contact that		
	person. * * definition from NM Forum -	SMART Performance Reporting White	Paper,
	September, 1995 (NMF/SPT95-15)		
	Superclasses: described language and Long	i ti vasuri užgariki uli ugin <b>ciat</b> ium Comto	
	<none></none>	e e e e e e e e e e e e e e e e e e e	
30	Roles/Associations:	e neuropalitation de la compania de	ì.ż
	hasContact in association Contact_Service	ceEntity (1) Commented Colonia and A	
	performedBy in association Contact_Fur		
	actsAs in association Person_Contact		
	Attributes:	e allor no de la concentración de la concentra	
35	serviceEntityId: integer	na dzi i win Miconsursbi	
	Foreign key to the service entity class. R		can be
	used for.	લાલા છે. હિં	

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serviceEntityType: short

Foreign key to service entity table.

personId: integer

Foreign key to the person class. References the person who acts as the contact.

personType: short

Foreign key to person table. This field always contains the same-value indicating the entity type is "PERSON". M. Burney

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 $function Desc Type: short \underbrace{ \{ \{ \{ \{ \{ \} \} \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \{ \} \} }_{\text{obstack}} \underbrace{ \{ \{ \{ \{ \} \} }$ 

Foreign key to the Fucntion Descriptor class.

10 Has-A Relationships:

<none>

Operations:

<none>

Class name:

#### ContractThreshold 15

Documentation:

Contract Thresholds are SLA Thresholds that are associated with a Contract. The SLA is a set of technical, administrative and management parameters that the service provider can report against. They typically are based on objective measures and have a high

correlation with the users' perception of the quality of service. Each parameter is typically a 20 a threshold that, when surpassed, means that the quality test in question has failed. \* \* definition from NM Forum - SMART Performance Reporting White Paper, September, 1995 (NMF/SPT95-15 recent will be even

THE M. Superclasses: - Line a limbo odw nostoly a softlenul of Line of the control of the

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Burg Associations: SMART Format - SMART Section 1.2 " To be sectional to the section of the sect usesThreshold in association ContractThreshold Contract and Contract a measuredAgainst in association ContractThresh SLAThresh Attributes:

30 contractId: integer

> A foreign key to the entity ID of the associated contract. contractType: shortno in the 191 and shockaren Charact Fieldhor Doln Foreign key to contract table. This field always contains the same value indicating the entity type is "CONTRACT".

35 thresholdType: short

Foreign key to the SLA Threshold Descriptor table

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The grant of the control of the **it does we** than the The numeric value of the threshold. Has-A Relationships: <none> Operations: <none> Class name: CONTRACTOR AND SERVICE REPORT Customer on green committee on the same of a factor of Documentation: The Customer is a legally identified organization that is contracting for the supply of one or more services from one or more service providers. \* \* definition from NM Forum -SMART Performance Reporting White Paper, September, 1995 (NMF/SPT95-15) THE RECOMMENDED OF STATE OF ST Superclasses: ServiceEntity Roles/Associátions: Tried to a syawin or final All Astronomore to enqua empre empre. belongsTo in association Customer\_Contract ownedBy in association Service\_Customer asking of fuments are asking Attributes: name: char[80] The name of the customer or company: The name of the customer or company: idNumber: char[20] A unique number identifying the customer and assigned by operational staff (i.e. เขาพารเดา อส์ว ยา เป็น พากุว ยา สตแสดวากุสส customizable). comments: char[255] Any comments pertaining to a specific customer may be added to this field. address: char[255] A street address for the customer. WW TW SEEL Has-A Relationships: 1355-1 <none> \* Operations: In this we be taken and an actual thin we be taken as a course of association of the feet the deleted white and control is solven. Delete() A customer cannot be deleted while it is associated with a contract or service. All related Class name: table of the

Contract

Documentation: 35

The Contract is a legal administrative and technical document describing what will be provided to the Customer, how and when it will be provided and the terms and condition

under which it will be provided. It also describes the obligations placed upon the Customer. \* \* definition from NM Forum - SMART Performance Reporting White Paper, September, 1995 (NMF/SPT95-15) Superclasses: ServiceEntity Roles/Associations:

maintains in association Customer\_Contract isContainedBy in association Contract Service usedIn in association ContractThreshold\_Contract

10 ... Attributes: ..., harry or the characters of the second and have been a customerId-; integer to the second of the se Foreign key pointing to the entity ID of the customer. customerType: short

Foreign key to customer table. This field always contains the same value indicating the

form the interest of the controlled

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15 entity type is "CUSTOMER". effectiveDate: time

The date on which the contract came into effect.

number : char[20]

A number used to track the contract against external systems. This number should be

20 unique.

> comments : char[255], while we have removed only got [ hards and it is only to the Any comments specific to the contract.

expiryDate: time

The date on which the contract expires a closus and transport of the contract expires and the co

25 Has-A Relationships:

<none>

Operations:

Delete()

A contract cannot be deleted while services are associated with it. All contact information

30 associated with the contract is deleted when the contract is deleted.

s dates betaleoceae ki ti slider beteral. Li totar l emic amp 1 The relation to a customer is set at creation time and cannot be changed subsequently. Class name:

Service

35 Documentation:

131 N. J. C. G. Mar. 18 1 , A Service is anything that the service provider determines that Customers wish to purchase and that the service provider is willing to supply .\* More specifically (within the

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context of Resolve), a Service is a telecommunications product sold to a Customer by a service provider which is managed by the service provider. Services include transmission facilities and associated applications. A Service can consist of multiple Service Components. \* definition from NM Forum - SMART Performance Reporting White

Paper, September, 1995 (NMF/SPT95-15) 5

Superclasses:

ServiceEntity and the account of the control of the

Roles/Associations:

contains in association Contract Service

owns in association Service Customer 10 describes in association ServiceProfile\_Service containedBy in association ServiceComponent\_Service Attributes:

customerId: integer

Foreign key to the customer class. References the customer who owns this service. 15 customerType: short

Foreign key to customer table. This field always contains the same value indicating the entity type is "CUSTOMER".

contractId: integer

Foreign key pointing to the entity ID of the contract. 20

contractType: short

Foreign key to contract table. This field always contains the same value indicating the entity type is "CONTRACT": i ca you make opinios alva a volumb at each or diff there eserviceProfileId: integer to main cash are sentiment. Subjects the best in the

Foreign key to Service Profile class: appropriate a pogrado a compagnation of A 25 serviceProfileType: short

Foreign key to service profile table. This field always contains the same value indicating tages having as a zero h the entity type is "SERVICE PROFILE". 

Europe earlier was modified on went emoral une.

inServiceDate: time

The date that the service came into effect. 30

serviceName: char[80]

A label for this service.

comments: char[255]

Any information added by the user which is specific to this service.

Has-A Relationships: 35

<none>

Operations:

Delete() jos 15 in the first of the contract of the first of Deletion of this class follows the rules of deletion for the entity class, and leads to deletion of all related contact information. CurrentService 14 7 mod 14 (2) 1000 me - 2 of 14 Documentation: This class is used to track current services. Current services become historical services everytime a modification is made to their associations with a customer, contract or service profile record. and the factor of the late of the second Superclasses: 10 Service some of the said of the said the said Roles/Associations: A the second of the seco <none> Attributes: The state of the s Has-A Relationships: and the Topping Snone - health him were in the him of the state and the same in Operations: <none> TRUMP ELOSATION 20 Class name: Burtons of the Clarket Every or give an ex-HistoricalService Muna ter Titar da t Documentation: education as the second section of the language of the language of the language. This class is used to track services that are no longer in use. This information is necessary for historical reporting. Everytime the associated customer, contract or service profile for a current service is changed, a historical service is created and a read agree of 25 ::0 Superclasses: รายได้เลยที่ไม่เมื่อต่องตัวแล <sub>สามระบาทกา</sub>Service ลากการสามราช พระหวัง ได้งดี งไม่รี่ เมื่องได้มี สนับหรุงอักษ์ตร กรรุงมี สาร์เลยรั Roles/Associations: PRIMORE TOWARD MEET PROPERTY <none> 155: 1. Juse mine 30 Attributes: the file that the verifice came that critecity expiryDate: time forthaid is made in Date the service was modified or went out of use. and the second of the second Has-A Relationships: ProChambing and and a <nore> .toppes tiff of office opera dud virons so, quiteles au mont dimen 35 Operations: CMONTHS IN FRANCE <none> Class name: 1290 C. 44

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on a gratical against the open to the last

#### Person

\*Documentation: in the last the confidence of the gast of the collection is

This class contains pertinent information on a specific individual. เรื่องและ (เมษา) จะสะ ดูสักที่ ลายแย่ หมา เรีย*ส สมส*ยาก รัก Superclasses:

AdminEntity

Roles/Associations:

hasProperties in association Person\_Contact hasProperties in association Person User Attributes: with the North Assessment of the real fact.

10 name: char[20]

Full name of the person.

position: char[40] and a true a true for a contract of management of the position of the property of the prope

Short description of position held within the given organization. the work of the more party by the bound out to about it.

organization : char[80]

Name of the organization with which this person is associated. n wordstanding the

telephoneNumber : char[20]

Telephone number associated with the person.

faxNumber: char[20]

Fax number associated with the person.

emailAddress: char[40] 20

Electronic mail address for the person.

mailingAddress : char[80]

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The described system provides an efficient method of managing service level 30 management agreements in a packet switched network that is capable of handling vast dabe en ros de les quibre arr quantities of data in a flexible manner.

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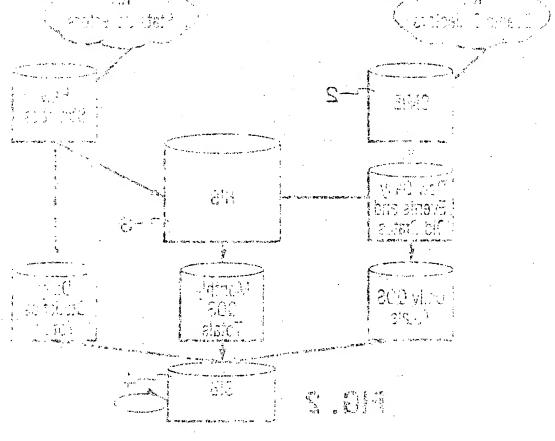
#### Claims:

- 1. A method managing a telecommunications network comprising the steps of:
- a) maintaining a database means containing data relating to service level agreements with customers using an object model,
  - b) receiving from the network data relating to the performance of the network,
- c) continually comparing the data received from the network with data stored in said database, and
- d) generating a report based on said data showing the performance levels for individual customers in meeting commitments stored in said database containing data relating to said service level agreements.
- 2. A method as claimed in claim 1, wherein said event is generated when the discrepancy between performance levels and commitments exceed a predetermined threshold value.
- 3. A method as claimed in claim 1 or 3, wherein a plurality of working table fragments forming part of a fragmented table are created in memory, data are loaded in successive predetermined time periods into successive table fragments in a predetermined sequence, and the data are processed separately when loaded into the table fragments.
  - 4. A method as claimed in claim 4, wherein the data loaded using a round robin technique.
- 5. A method as claimed in any one of claims 1 to 4, wherein descriptors implemented as an object oriented class are used to store meta information on other classes in the system.
  - 6. A method as claimed in any one of claims 1 to 4, wherein a base descriptor class provides a template where unique identifiers, names and descriptions are stored.
- 7. A method as claimed in claim6, wherein derived classes are used to define additional qualities for specific descriptors.
  - 8. A method as claimed in claim 7, wherein derived classes are implemented for service entities, functions, statistics, Service Level Agreement thresholds, operations, service components, etc...
- 30 9. A telecommunications network service level manager comprising:

  a) database means containing data relating to service level agreements with customers using an object model;
  - b) means for receiving from the network data relating to the performance of the network;
- c) means for continually comparing the data received from the network with data stored in said database, and
  - d) means for generating a report based on said data showing the performance

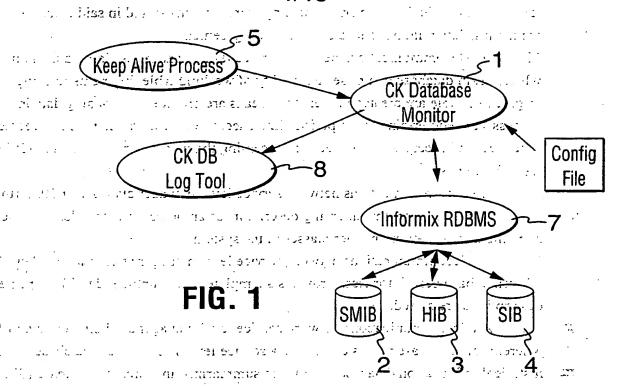
levels for individual customers in meeting commitments stored in said database containing data relating to said service level agreements.

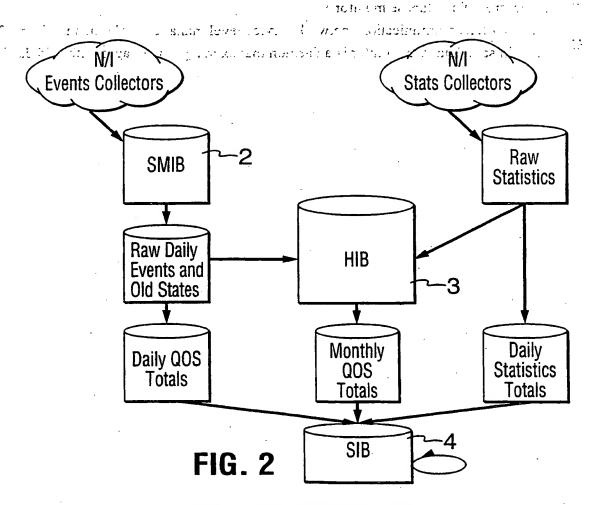
- 10. "A telecommunications network service level manager as claimed in claim 9, wherein said database comprises a plurality of working table fragments forming part of a fragmented table are created in memory, means are provided for loading data in successive predetermined time periods into successive table fragments in a predetermined sequence, and means are provided for processing the data separately when loaded into the table fragments.
- 11. A telecommunications network service level manager claims 9 or 10, further comprising means for implementing descriptors as an object oriented class are used to store meta information on other classes in the system.
  - 12. A telecommunications network service level manager as claimed in claim 11, wherein a base-descriptor class provides a template where unique identifiers, names and descriptions are stored.
- 13. A telecommunications network service level manager as claimed in claim 11, wherein said database means comprises a service level management database (SMIB), a historical information database (HIB), and summarized information database (SIB) under the control of a database monitor.
- 14. A telecommunications network service level manager as claimed in claim 13, wherein said database monitor is a daemon that exchanges messages with said databases.



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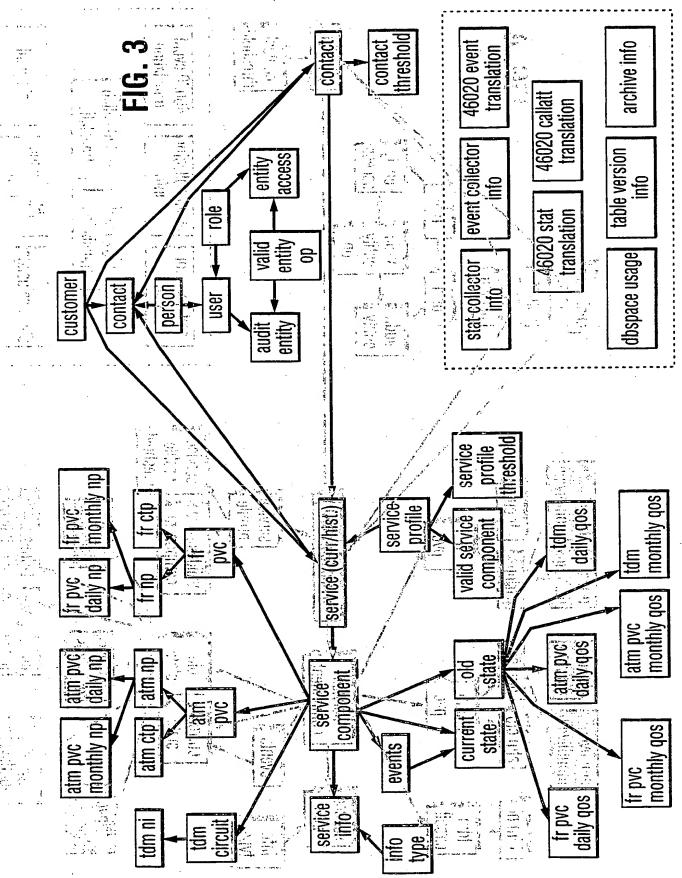




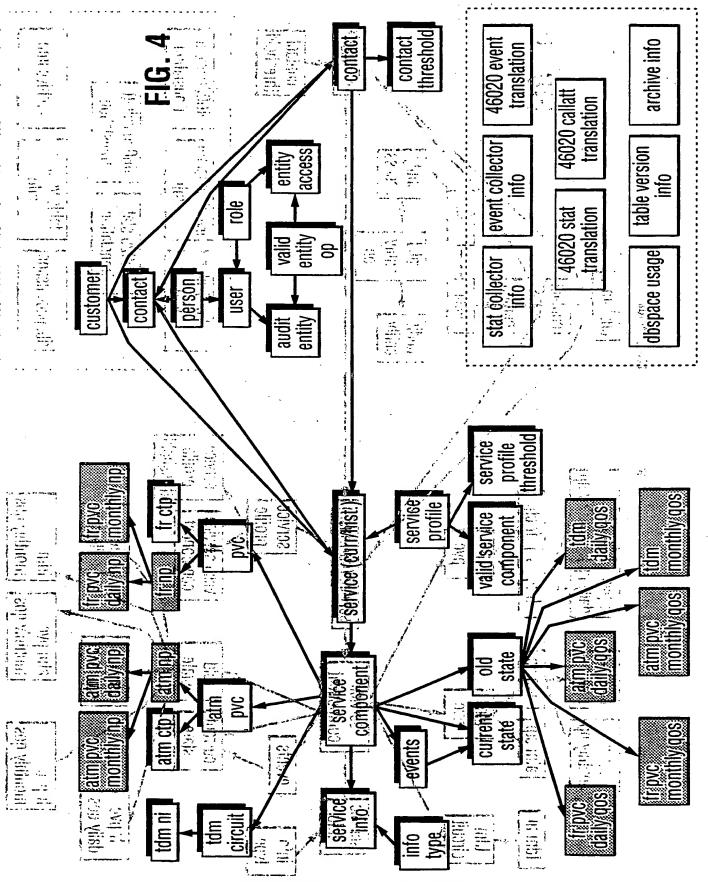
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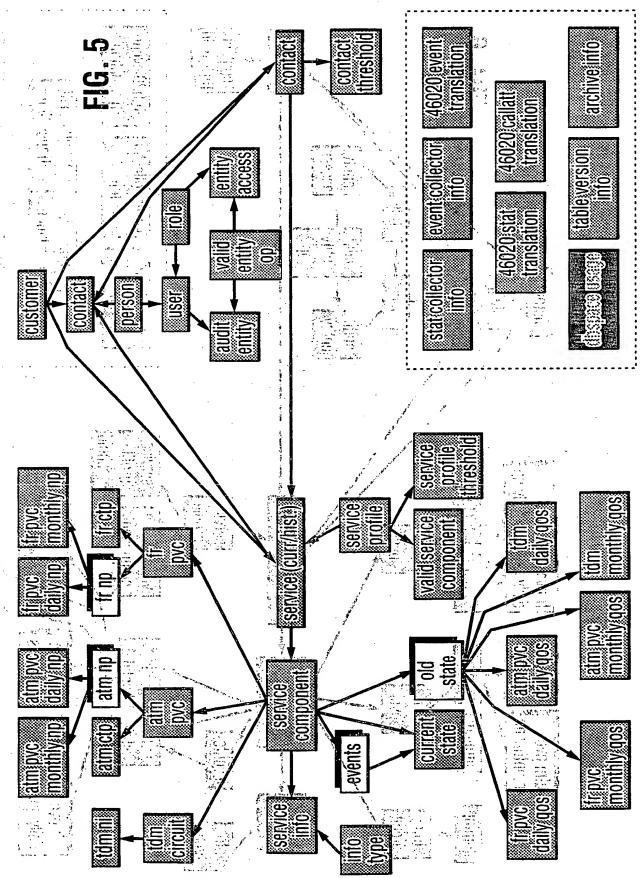


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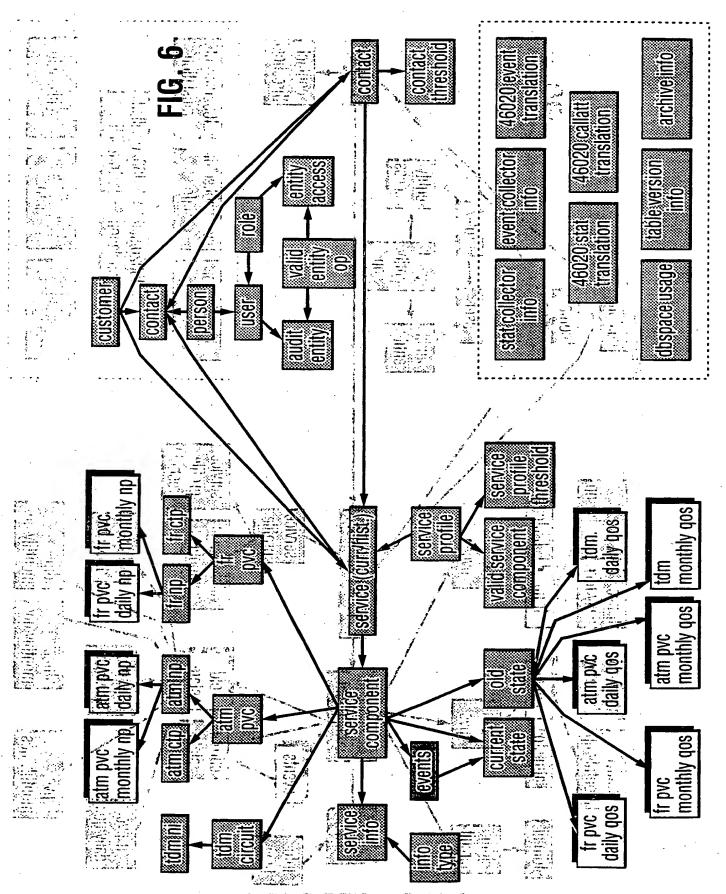


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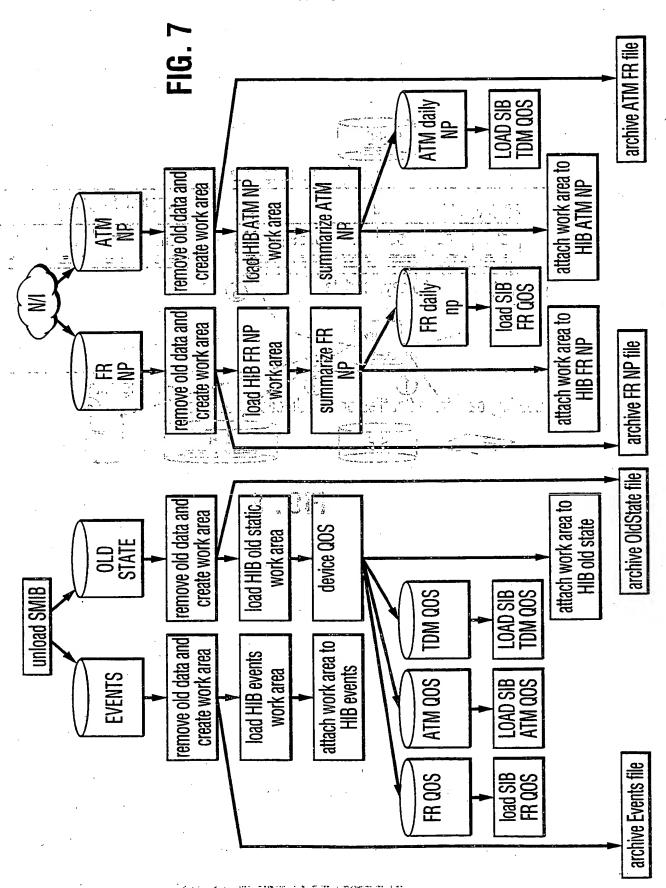


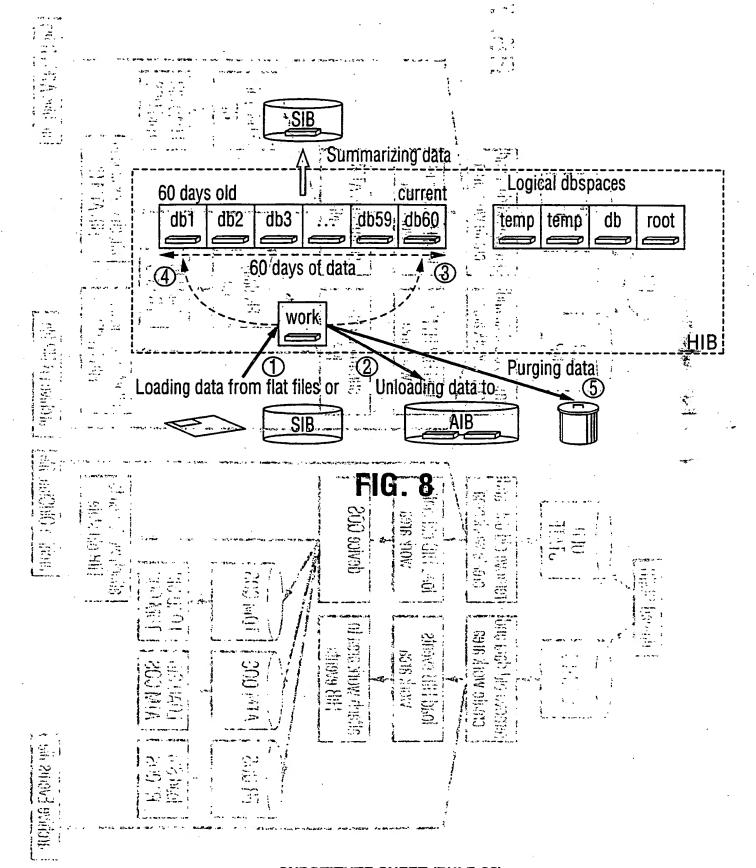
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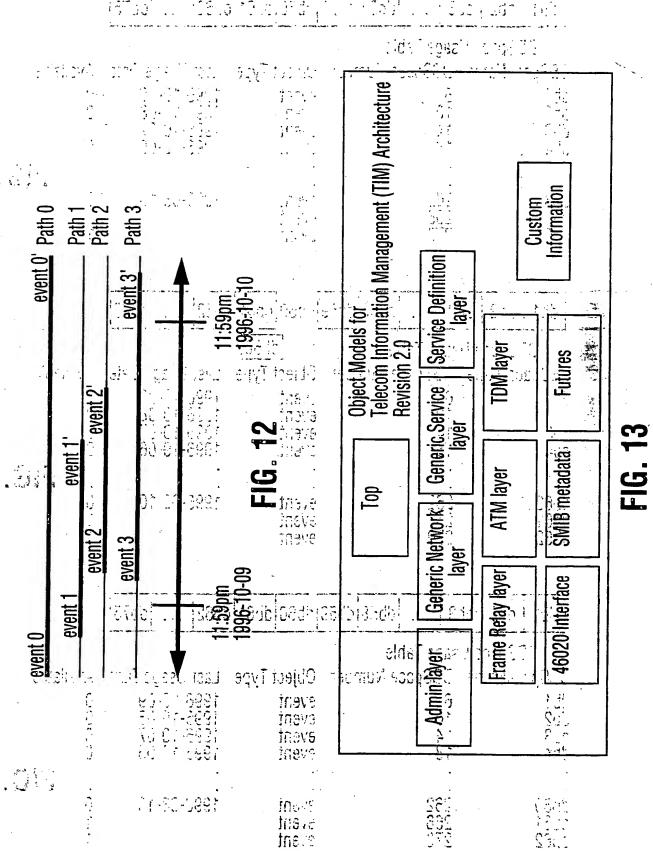


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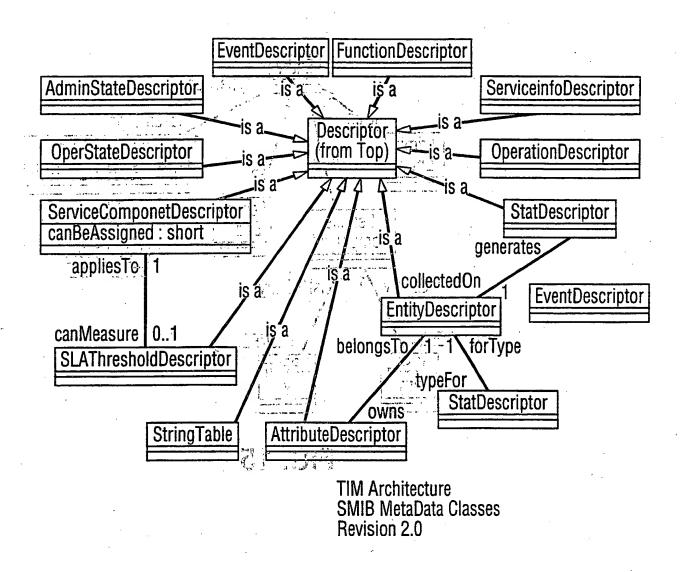
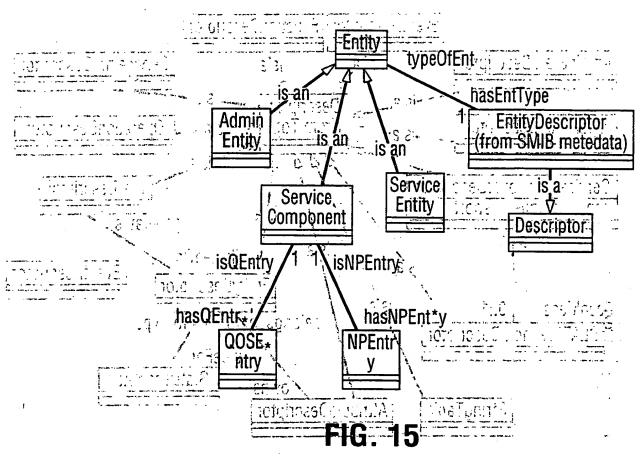




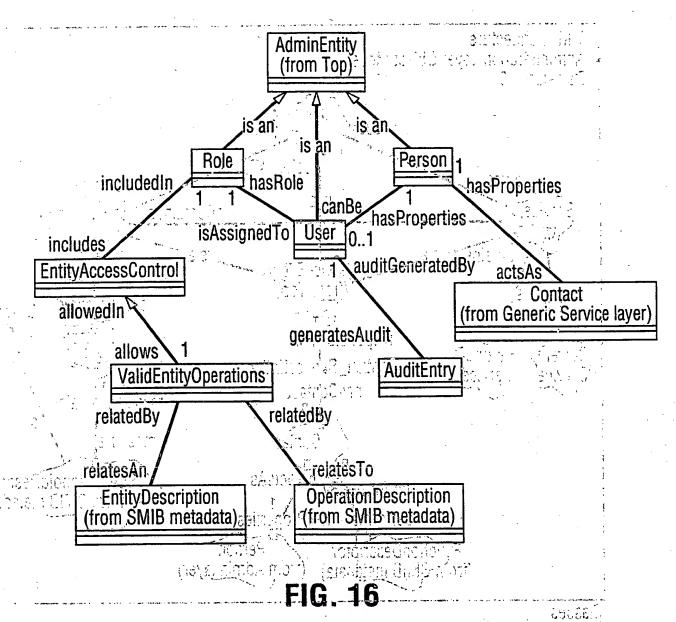
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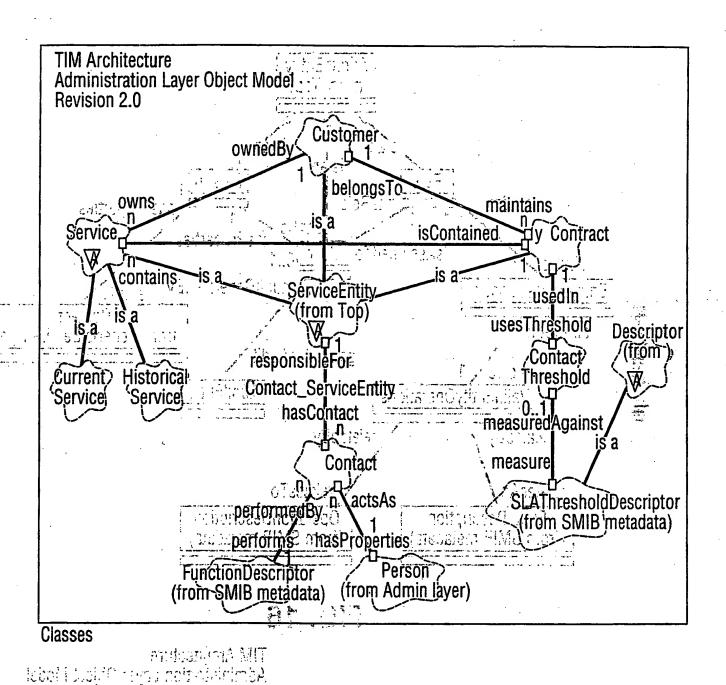


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